



Vegetation Resilience and Resistance and the Importance of the Herbaceous Understory

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Resilience, Resistance and Thresholds

- Resilience = the capacity of an ecosystem to regain characteristic processes over time following stress or disturbance
- Thresholds are crossed when an ecosystem does not return to the original state via natural processes following disturbance, and requires active management to restore



Resistance, Resilience and Thresholds

- Resistance = the ability of an ecosystem to maintain characteristic processes despite various stressors or disturbances
- Resistance to invasives = the biotic and abiotic factors and ecological processes in an ecosystem that limit the population growth of an invading species



Great Basin Vegetation Types



Limber Pine



Mtn Brush &
Woodland



Sagebrush



Salt Desert Shrub

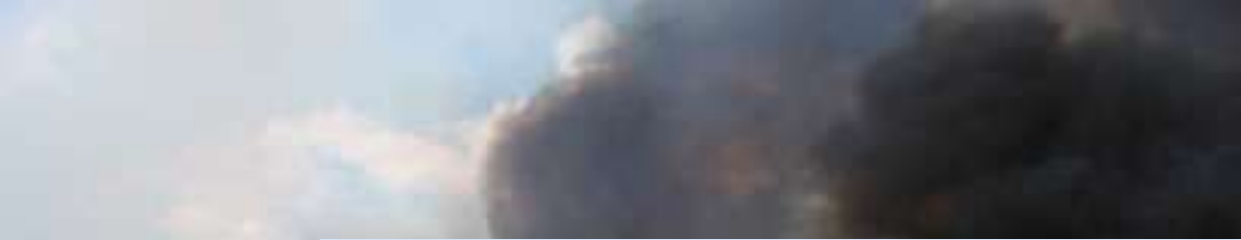
4"

12"

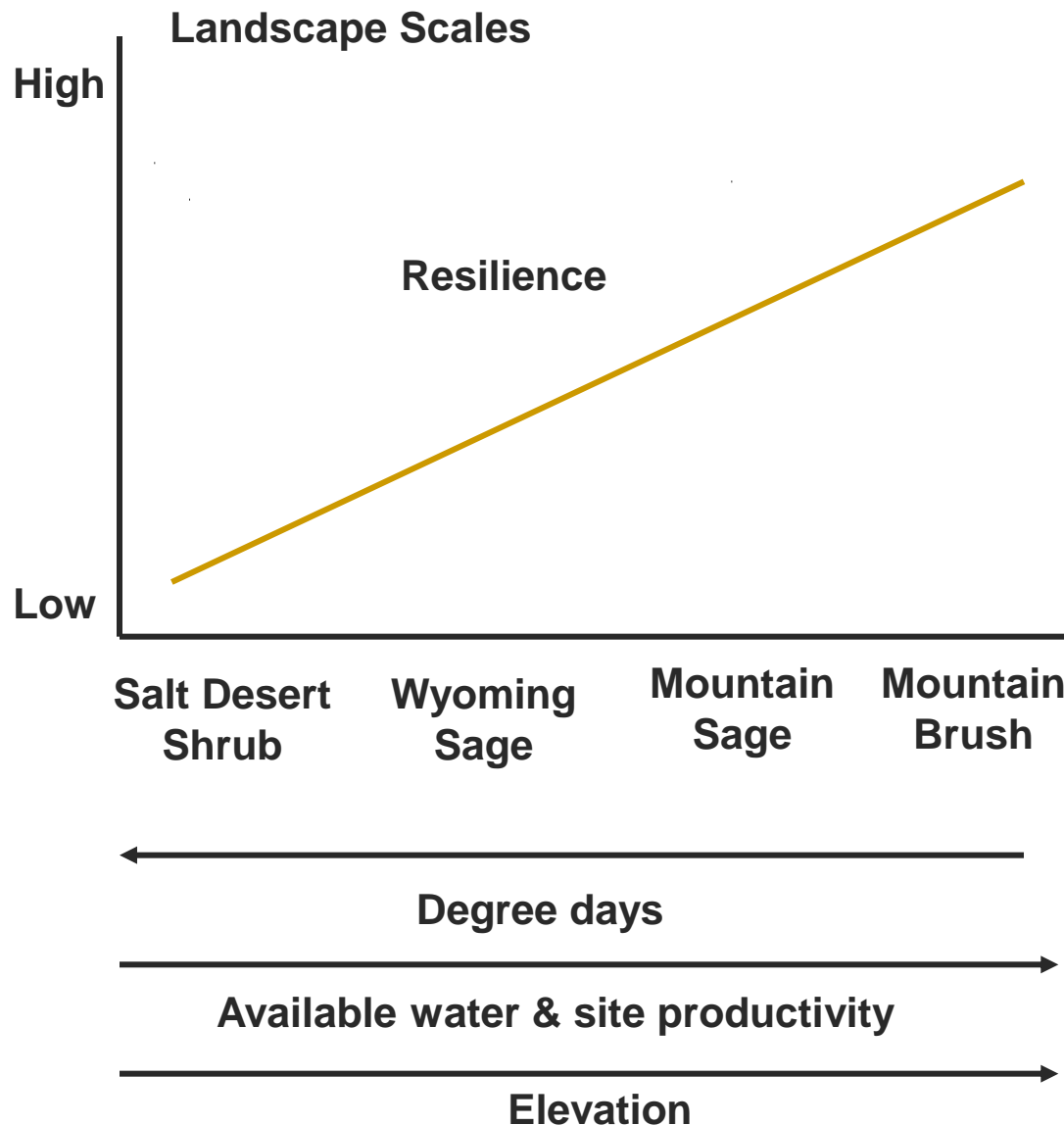
24 +"

Annual Precipitation



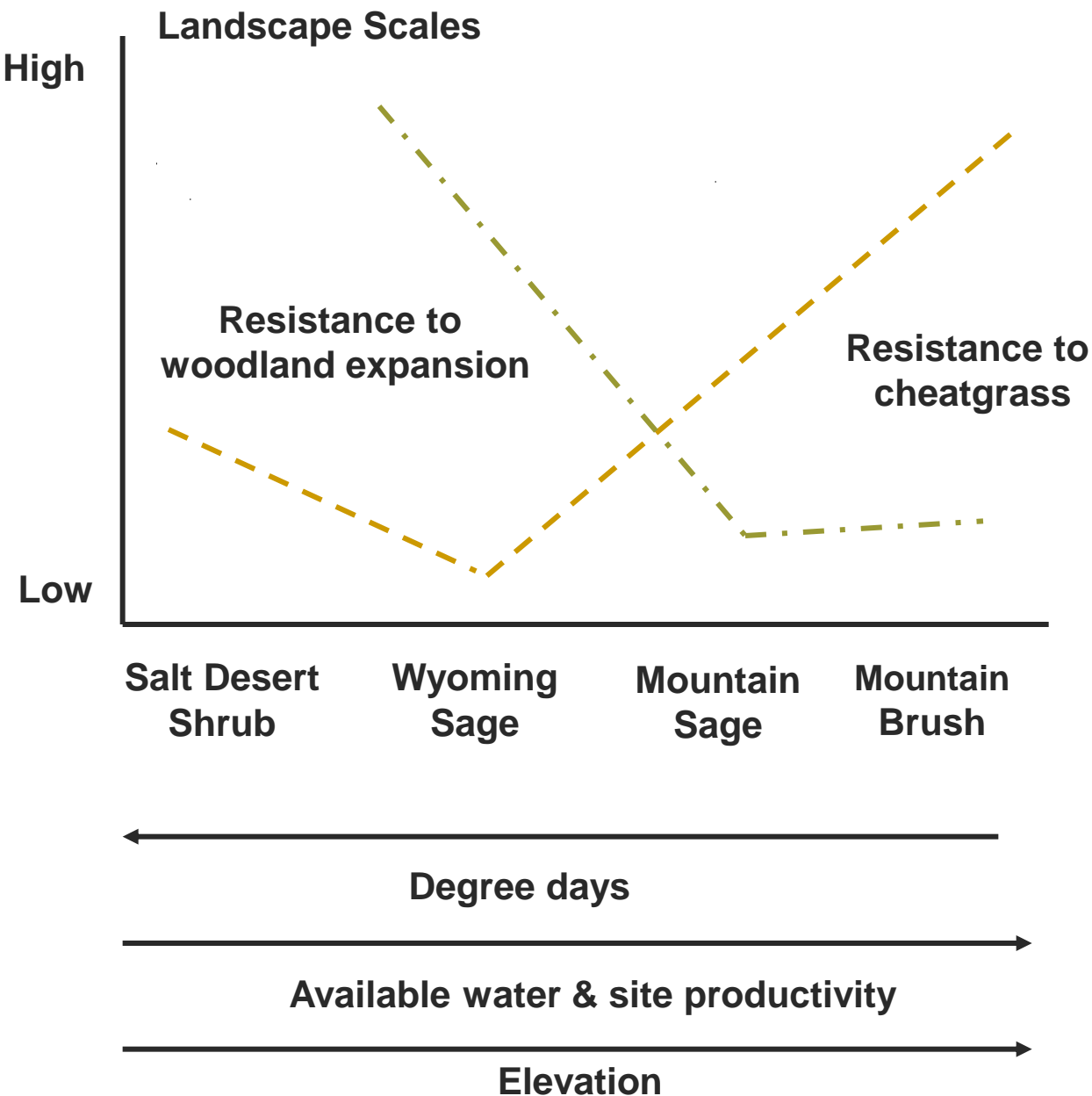






Resilience increases with elevation over gradients of available resources and net productivity

- Higher productivity & more favorable growing conditions
- More rapid recovery after disturbance
- Increased capacity to compete with invaders



Resistance to invasive species reflects their ecological amplitude

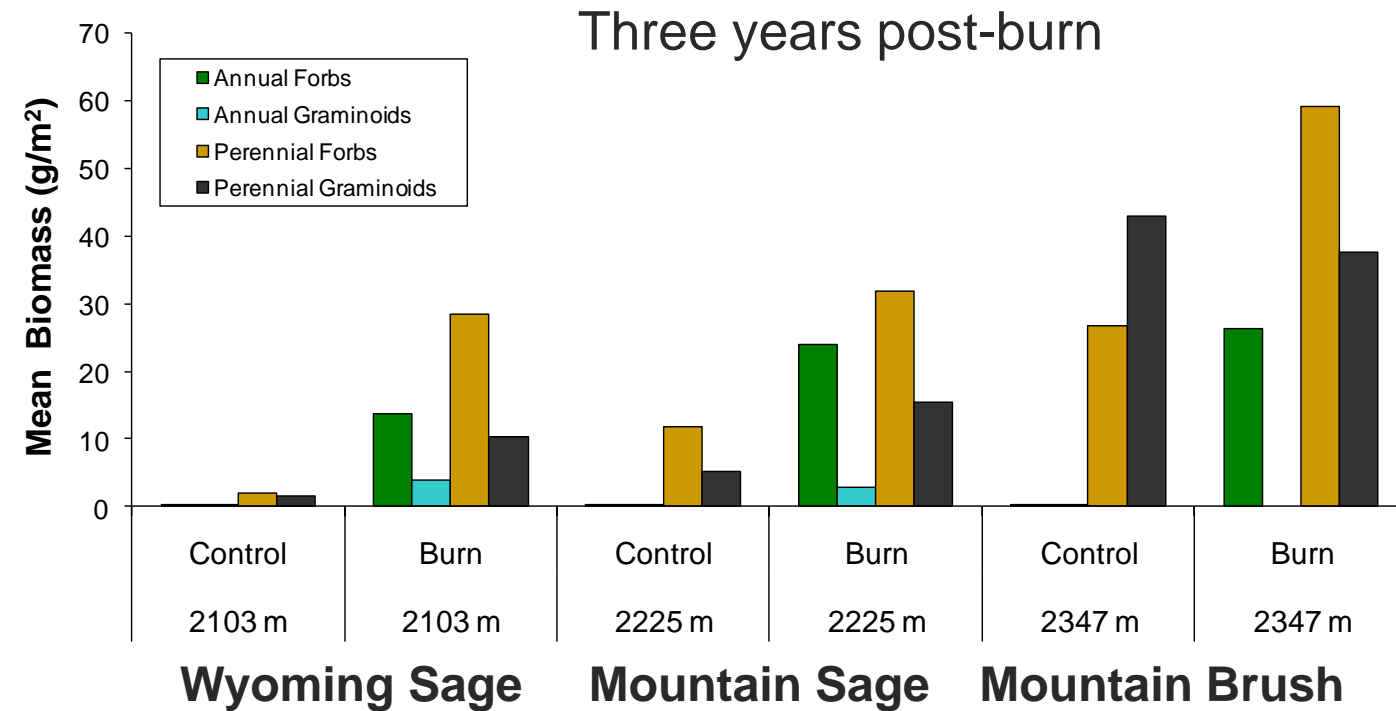
- Resistance is higher in stressful environs
- Historically, Wyoming sage least resistant to cheatgrass
- Mountain sage least resistance to trees

Factors that Influence Resistance and Resilience at Local Scales

- Ecological memory –
 - ❖ Site potential as indicated by soils and precipitation
 - ❖ Species composition and ecological condition as indicated by native seed banks and seed sources, and residual plants and animals
 - ❖ Presence, abundance & type of invasive species
- Severity and frequency of disturbance -
 - ❖ Inappropriate livestock grazing, high intensity fires, and fire return intervals less than the historical interval



Effect of Fire and Elevation



Productivity & site potential change with elevation

- Herbaceous biomass increases with elevation both pre- and post burn
- Higher productivity can result in greater resilience and resistance

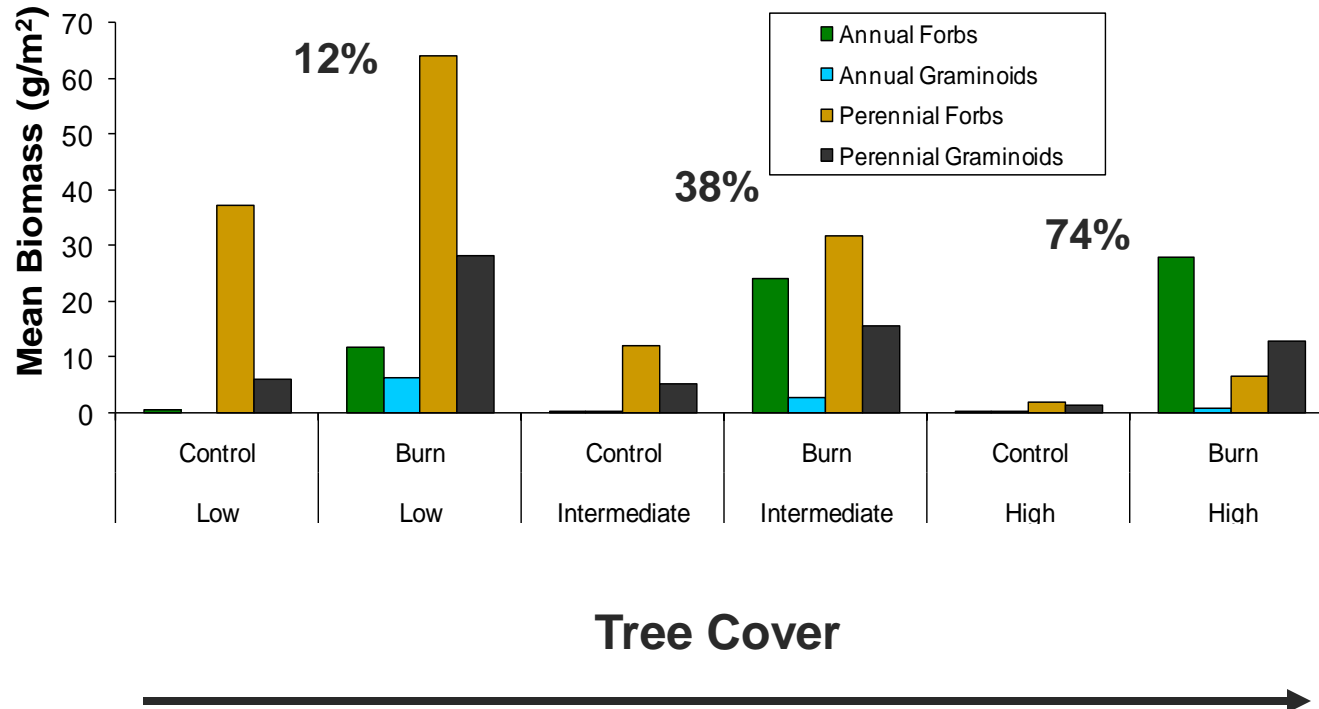
Intermediate Tree Cover (~30 to 40%)

(Dhaemers & Chambers in process)



Effect of Tree Cover and Fire

Three years post-burn

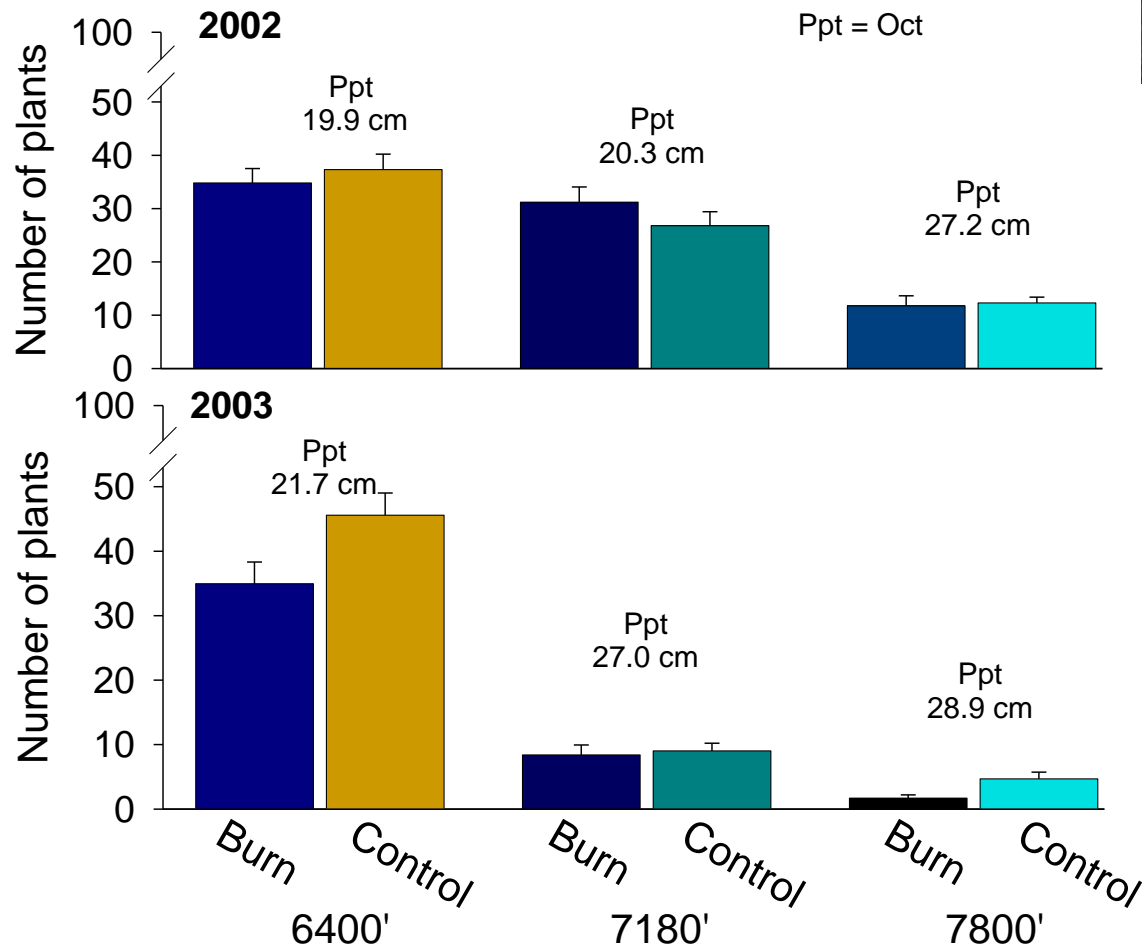


Ecological memory decreases with increasing tree cover

- Perennial herb biomass decreases with tree cover both pre- and post burn
- Annual herb biomass increases with tree cover
- Resistance and resilience decrease as tree cover increases

(Dhaemers & Chambers in process)

Effect of Elevation, Herbaceous Species and Fire

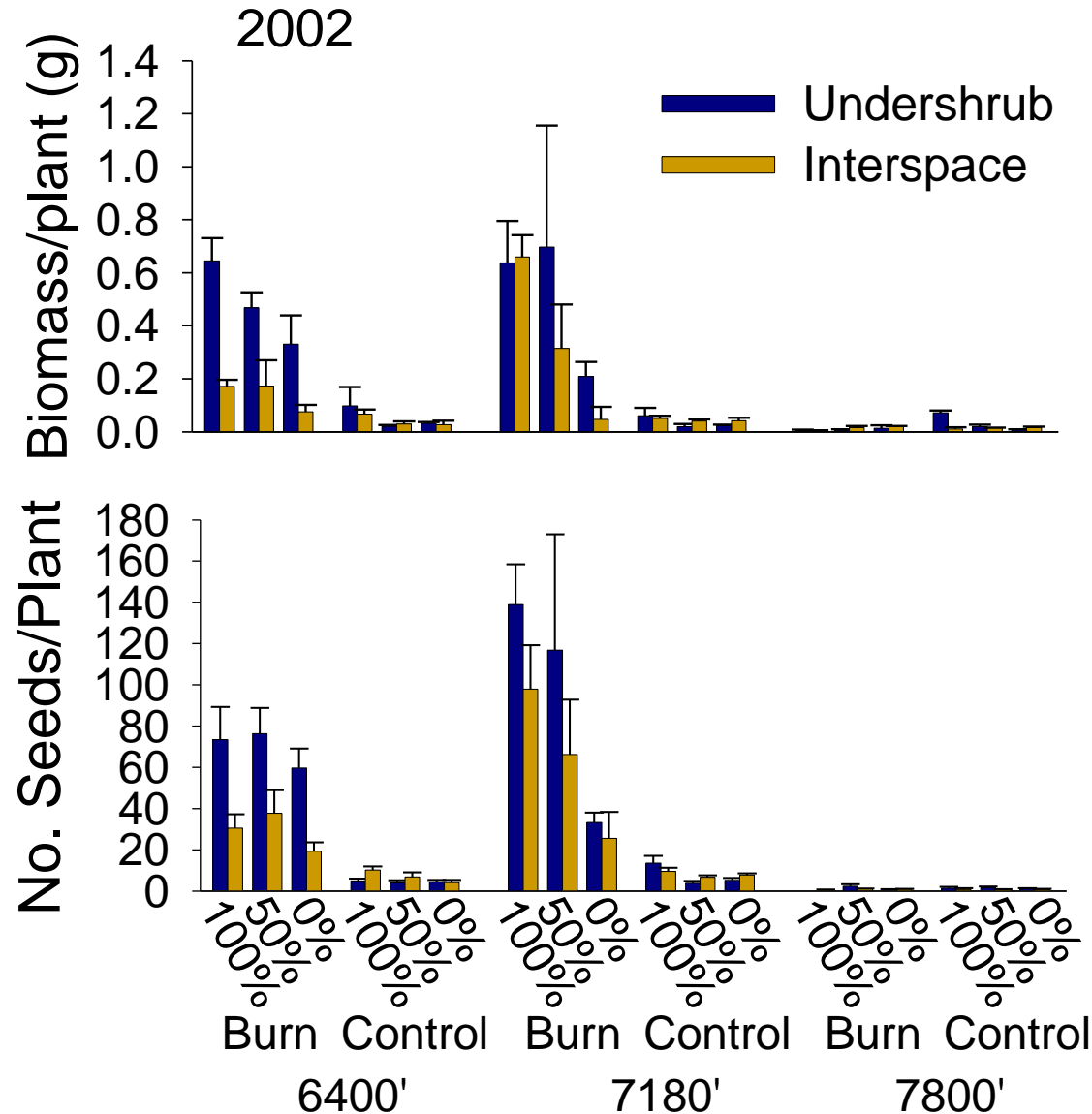


Ecological resistance increases with elevation

- Higher elevations and colder soil temperatures result in ecophysiological constraints
- Site characteristics and growing season conditions have greater effects on establishment than fire or herbaceous species removal

(Chambers et al. 2007)

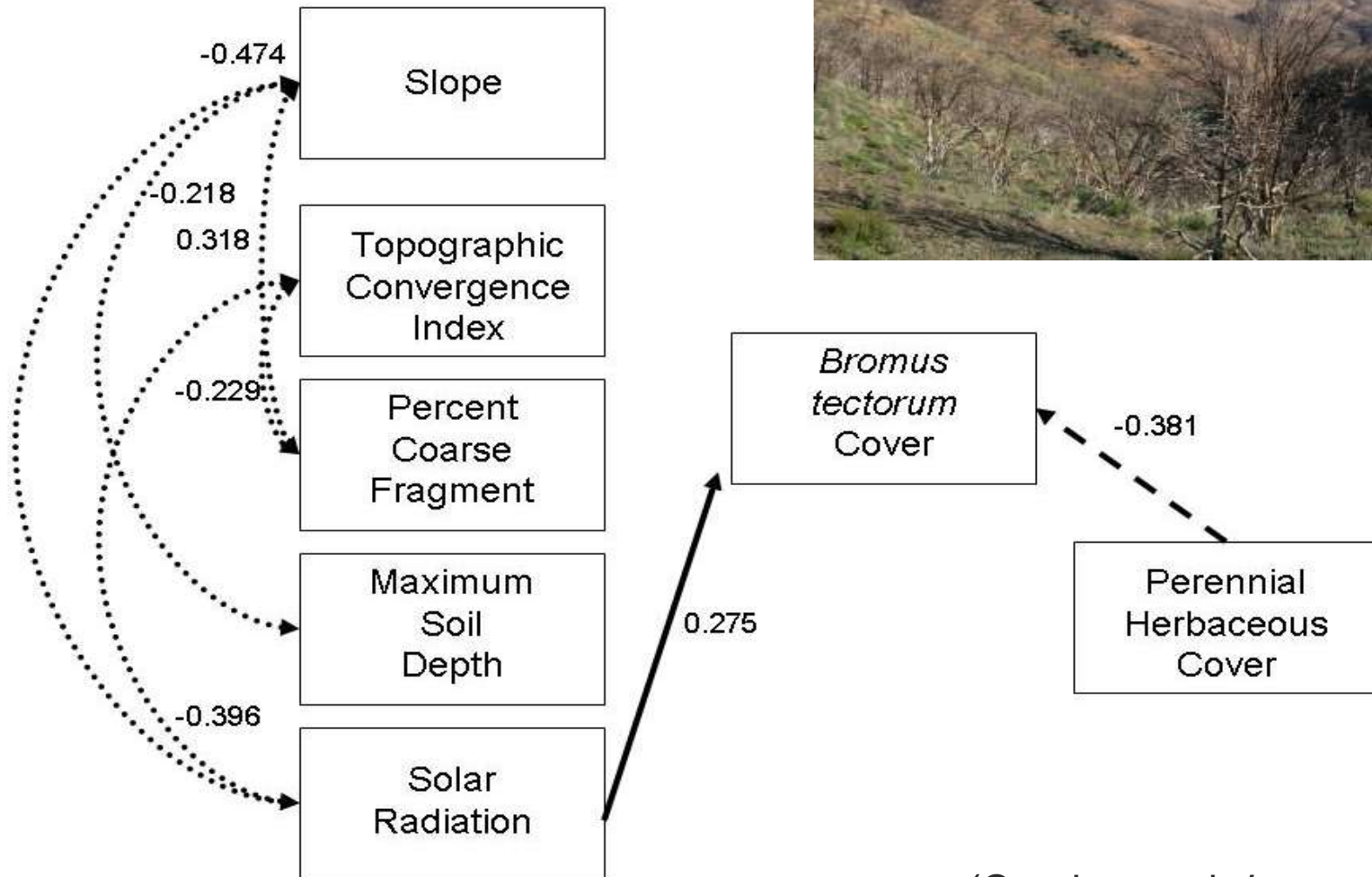
Effect of Elevation, Herbaceous Species and Fire



Effects of burning and removal on growth and reproduction are additive & similar over elevations

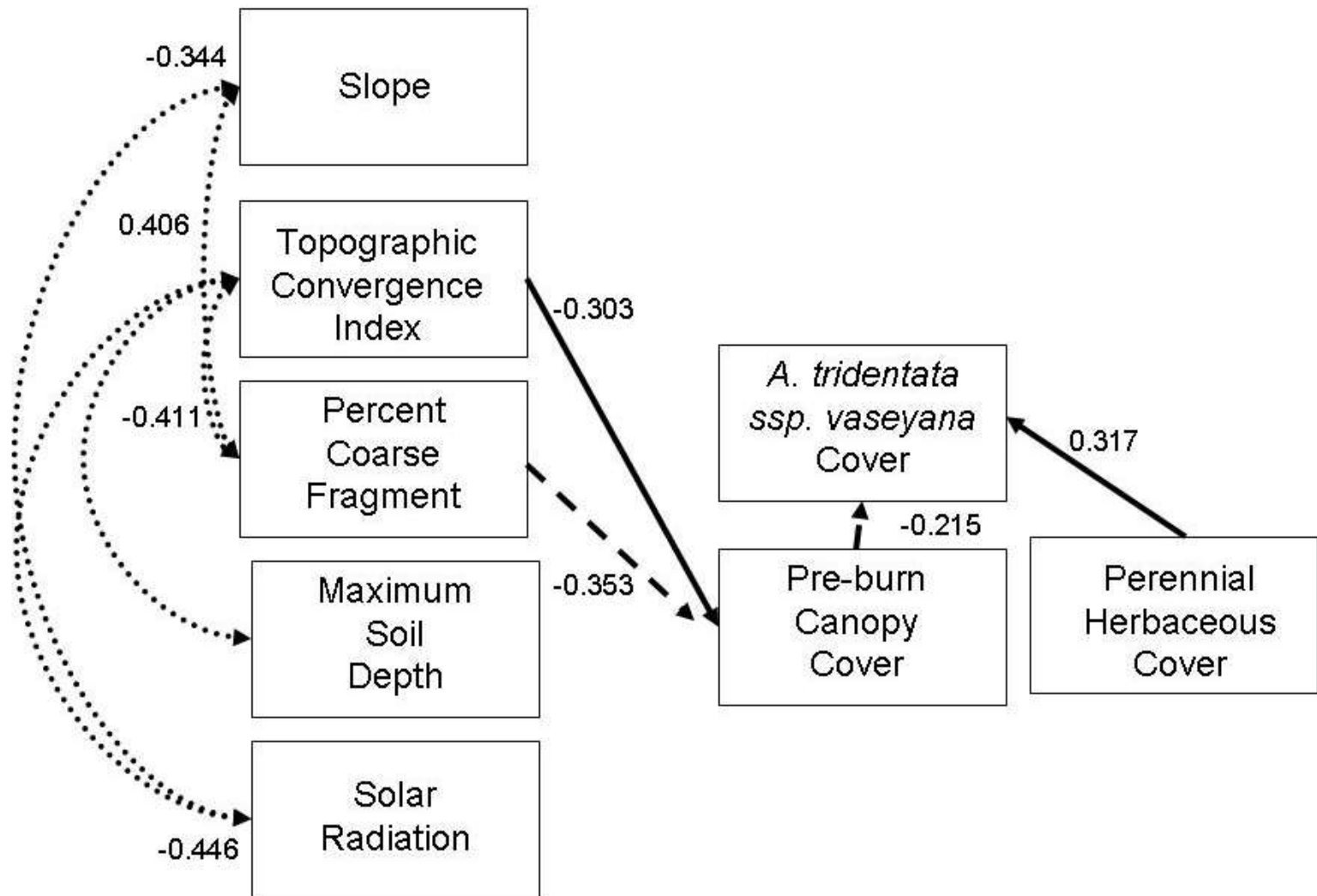
- ❖ Removal – 2 to 3 fold
- ❖ Burning – 2 to 6 fold
- ❖ Removal + Burning – 10 to 30 fold
- Disturbances that increase resources decrease resistance
- Mechanism is growth and reproduction after establishment
- Perennial herbaceous species increase resistance via competition for resources

Landscape Level Controls on *Bromus tectorum*

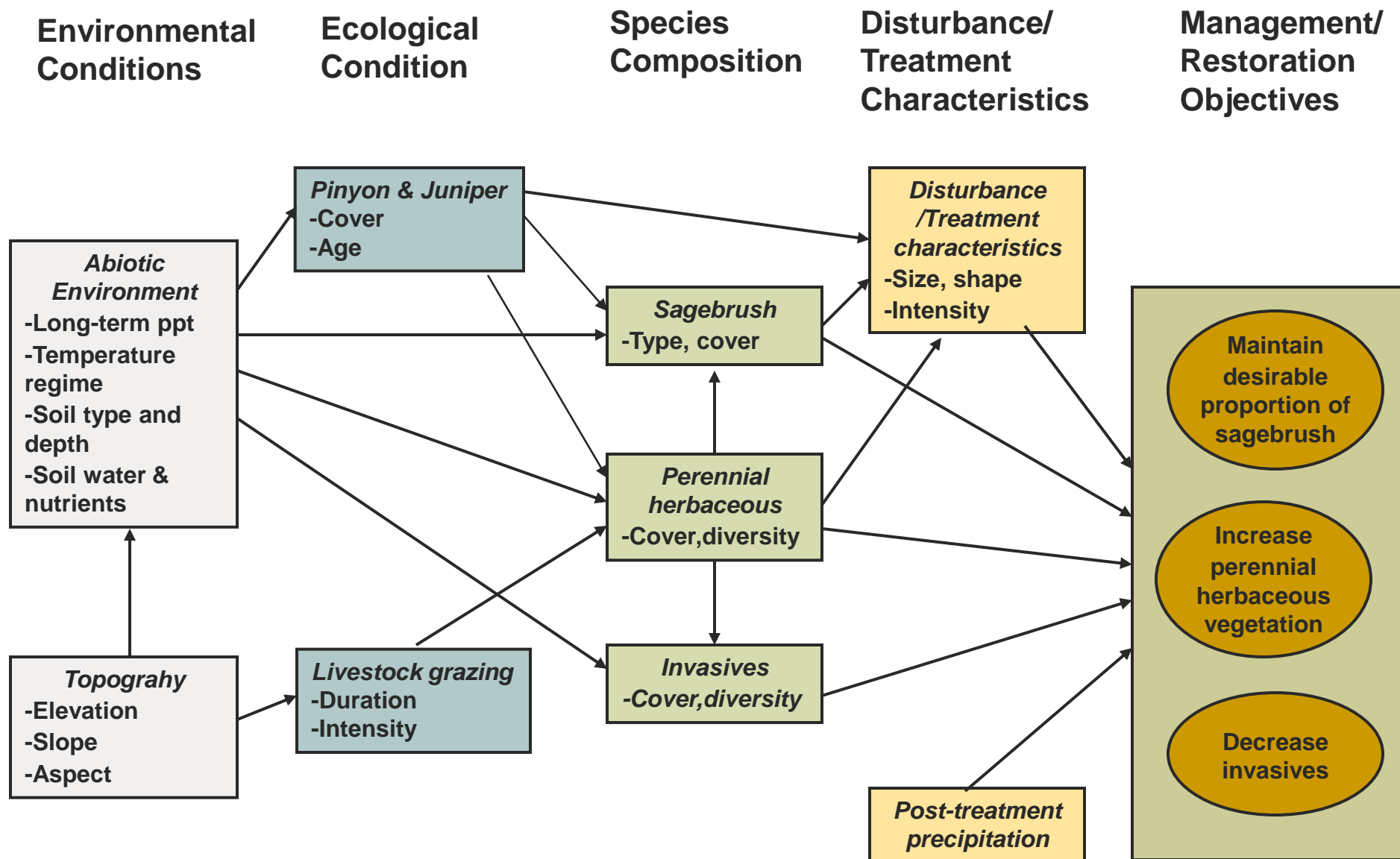


(Condon et al. *in press*)

Landscape Level Controls on *A. tridentata*



(Condon et al. *in press*)



[Management Approach

- A basic approach for managing and restoring these ecosystems using the concepts of resistance and resilience includes:
 - ❖ First → assess environmental characteristics, vegetation types and ecological conditions at landscape scales.
 - ❖ Second → develop an understanding of ecological resistance and resilience and relationship to thresholds for the ecosystems of interest (e.g. Stagestep.org).
 - ❖ Third → prioritize management activities at landscape scales. Categories include Protection, Prevention and Restoration/Rehabilitation.



Prioritization

- ***Protect*** areas with inherently low resistance or resilience
 - Eliminating stressors like repeated fire and inappropriate livestock grazing
 - Control disturbances and invasion
- ***Prevent*** threshold crossings by increasing resistance and resilience
 - Eliminate stresses, control disturbance and invasion
 - Increase herbaceous perennials; reduce woody fuel loads
 - Implement vegetation management treatments
- ***Restore/Rehabilitate*** high priority areas
 - Critical habitat for T&E species, fire breaks for intact systems, wildland/urban interface, ESR/BAER seeding

Case Study – North Monitors Tree Expansion



10"

14"

18"

Resilience

Resistance



Black Sagebrush
Wyoming Sagebrush



Cut and Leave



Masticate

Resilience & Resistance

- Elevation – relatively low
- Precipitation & productivity - moderately low
- Ecological condition – good
- Abundance of invasives – cheatgrass present; locally abundant
- Grazing – allotment vacant

Management Implications

- Slower recovery due to low productivity
- Higher risk of cheatgrass spread, especially after fire
- Lack of fine and contiguous fuels
- Use mechanical treatments
- Minimize surface disturbance
- Manage grazing



Mountain Sagebrush



Cut and Leave



No Treatment

Resilience & Resilience

- Elevation – intermediate
- Precipitation & productivity -moderate
- Ecological condition – fair/low
- Abundance of invasives – cheatgrass present; locally abundant
- Grazing – allotment active

Management Implications

- Low recovery due to high tree cover & depleted understory
- Higher risk of cheatgrass spread, especially on South slopes
- Higher risk of severe fire
- Treat areas with low tree abundance – use mechanical methods
- Create fuel breaks
- Revegetate following fire
- Manage grazing



Resilience & Resilience

- Elevation – high
- Precipitation & productivity -moderately high
- Ecological condition – good
- Abundance of invasives – cheatgrass largely absent
- Grazing – allotment active

Management Implications

- Higher recovery rates
- Lower risk of cheatgrass spread
- Lower risk of severe fire
- Treat with prescribed fire
- Manage grazing
- ❖ Monitor results – adapt management

The Road Forward

- Prioritizing restoration and management activities based on resistance and resilience can:
 - Increase sustainability
 - Maintain ecosystem services
 - Provide for species of concern
 - Adapt to a changing climate
- The Great Basin Science Delivery Project & other USDA and JFSP management & research efforts are:
 - Providing information on the effects of management actions on resistance and resilience across diverse landscapes
 - Developing syntheses on these concepts and how to apply them



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